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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Brent Keeth et al.

Serial No.: 08/530,661

Filed: Sept. 20, 1995

For: Semiconductor Memory Circuitry

Group Art Unit: 2814

Examiner: N. Kelley

Atty. Dkt. No.: MCRO:266/AUC

BRIEF OF APPELLANT PER 37 C.F.R. 1.192(a)

To: Assistant Commissioner for Patents
Washington, D.C. 20231

Enclosed is Appellants' Appeal Brief, submitted in triplicate, in support of Appellants' Notice of Appeal filed Sept. 13, 1999. A check for \$ 300.00 is enclosed in payment of the filing fee required under 37 C.F.R. §1.17(f). Please deduct any deficiency or refund any excess to Deposit Account 01-2508, Order No. MCRO:266/AUC.

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I. REAL PARTY IN INTEREST.

The real party in interest of this application is Micron Technology, Inc. as evidenced by the full assignment of the pending application to Micron Technology, Inc. recorded at Reel 7671, Frame 0965 in the Assignment Branch of the Patent and Trademark Office.

II. RELATED APPEALS AND INTERFERENCES.

Appellants, Appellants' undersigned legal representative, and the assignee of the pending application are aware of no appeals or interferences which will directly affect, be directly affected by, or have a bearing on the Board's decision in the pending appeal, other than an Appeal No. _____ filed on about Sept. 21, 1999, by Appellants in Serial No. 08/603,471 filed Feb. 20, 1996, which concerns related issues.

III. STATUS OF CLAIMS.

Claims 1 to 27 have been presented for examination.

Claims 1 to 27 are pending in the application.

Claims 1 to 5, 11 to 17, 20 to 21, 24, and 27 are withdrawn from consideration.

Claims 6 to 10, 18 to 19, 22 to 23, and 25 to 26 stand finally rejected, and are being appealed.

IV. STATUS OF AMENDMENTS.

No amendment to the application has been submitted subsequent to final rejection.

V. SUMMARY OF INVENTION.

The claimed inventions are memory die or devices having smaller size or consumed monolithic die area than did prior art devices. (*See, specification at p. 34, lines 20-23.*) In one aspect, the claimed invention encompasses a 16M semiconductor memory device comprising a total of from 16,000,000 to 17,000,000 functional and operably addressable memory cells occupying an area on a semiconductor die which is no greater than 14 mm². (*See, for example, specification at p. 37, lines 15-21.*)

In another aspect, the above-mentioned 16M semiconductor memory device further comprises peripheral circuitry and pitch circuitry formed on the die relative to the memory arrays. (*See, for example, specification at p. 37, line 24 through p. 38, line 3.*) The peripheral circuitry, pitch circuitry and memory arrays have a total combined continuous surface area which is less than or equal to 35 mm². (*See, for example, specification at p. 38, line 3.*)

In another aspect, the above-mentioned peripheral circuitry, pitch circuitry and memory arrays have a total combined continuous area on a die which is less than or equal to 32 mm². (*See, for example, specification at p. 38, lines 11-14.*)

In yet another aspect, the invention encompasses a 16M semiconductor memory device having a total of from 16,000,000 to 17,000,000 functional and operably addressable memory cells arranged in multiple memory arrays. (*See, for example, specification at p. 37, lines 15-18.*) At least one of the memory arrays contains at least one area of 100 square microns of continuous die surface area which has at least 128 of the functional and operably addressable memory cells. (*See, for example, specification at p. 38, lines. 3-6.*)

In another aspect, the above-mentioned at least one area of 100 square microns has at least 170 of the functional and operably addressable memory cells. (*See, for example,* specification at p. 38, lines 14-16.)

VI. ISSUES.

1. Are the inventions of claims 6-10, 18-19, 22-23 and 25-26 sufficiently described in the specification such that a person of ordinary skill in the art is enabled to make and use the inventions within the meaning of 35 U.S.C. § 112 paragraph 1?
2. Are the inventions of claims 6-10, 18-19, 22-23 and 25-26 patentable under 35 U.S.C. § 103(a) over the appellants' discussion of the prior art in view of Denboer ("Inside Today's Leading Edge Microprocessors," Semiconductor International, 1/1994)?

VII. GROUPING OF CLAIMS.

For this appeal, claims 6-10, 18-19, 22-23 and 25-26 stand or fall as one group.

VIII. ARGUMENT.

A. Summary Of The Examiner's Rejections.

Claims 6-10, 18-19, 22-23, and 25-26 stand rejected under 35 U.S.C. § 112, paragraph 1. (Paper 20, at 2; Paper 16, at 2-5.) The Examiner admits that the Appellants' specification is "enabling for structures formed through the use of applicant's disclosed improved techniques and resultant structures (e.g. applicant's bird's beak reduction, increased storage node capacitance, at least five conductive lines, elimination of field oxide techniques, etc.)." (Paper 16, at 2-3.)

However, the Examiner states that “[n]one of these methods, or any of their corresponding structural manifestations, are recited in the rejected claims. Instead, applicant’s claims are written in terms of maximum device density. As such, the scope of applicant’s claims includes all devices having the density achieved by applicant as well as all future improvements in density, made through any means, known or unknown.” (Paper 16, p. 3)

In general, the Examiner contends that the scope of enablement provided to one skilled in the art by the disclosure is not commensurate with the scope of protection sought by the claims. (Paper 16, at 3-5.) The Examiner recognizes that “the semiconductor industry has been unable to produce applicant’s claimed structure despite a continuing goal to do so” and concedes that “[a]pplicant may be entitled to a patent because no prior artisan has been able to produce the claimed invention.” (Paper 16, at 4-5.) Nevertheless, the Examiner “maintains that the ability to make the claimed invention through the use of a method other than those disclosed is not within the level of ordinary skill in the art” and concludes “[a]pplicant’s disclosure is enabling only for devices made through the use of the disclosed methods and including the disclosed structural features of these methods.” (Paper 16, at 5.)

In the Final Office Action of March 12, 1999, the § 112 rejection was maintained for the reasons of record. (Paper 20, at 2.) The Examiner responded to appellants’ remarks by stating that “one skilled in the art cannot make a structure with the claimed density without the use of applicant’s disclosure. If that is the case, then the level of ordinary skill in the art cannot satisfy the enablement requirement for that portion of the applicant’s claims scope which is beyond that enabled by the applicant.” (Paper 20, at 3.)

Claims 6-10, 18-19, 22-23, and 25-26 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over applicant's discussion of the prior art in view of Denboer ("Inside Today's Leading Edge Microprocessors," Semiconductor International, 2/1994). (Paper 16, at 5.) The Examiner points out that the applicant's "BACKGROUND OF THE INVENTION" discloses that "[m]aximizing density of single transistor and other memory cells is a continuing goal in semiconductor memory fabrication." (Paper 16, p. 5.) The Examiner also notes that "Denboer further discusses the goal of minimizing device size and discusses a structure which achieves a small size and uses 5 conductive layers (note page 2, middle col.)." (Paper 16, at 5-6.) The Examiner then concludes that "[i]t would have been obvious to one skilled in the art at the time the invention was made to make 16M DRAM chips with ever increasing device density because, as applicant admits, 16M DRAM chips existed in the prior art at the time of invention and because maximizing density of single transistors and other memory cells is a continuing goal in the art. Furthermore, since applicant discloses that one way to achieve the claimed structure is through the use of at least 5 conductive layers and since Denboer teaches the known use of such a structure, the examiner maintains that one skilled in the art would be able to produce the claimed structure." (Paper 16, at 6.)

In the Final Office Action of March 12, 1999, the § 103(a) rejection was maintained for the reasons of record. (Paper 20, at 2.) The Examiner maintained that "one skilled in the art producing 16M chips with the desire to make them smaller would be led to the use of five conductive layers given Denboer's discussion." (Paper 20, at 4.)

B. Summary of Appellants' Argument.

The Examiner has already agreed that the appellants' application is "enabling for structures formed through the use of applicant's disclosed improved techniques and resultant structures" and that the "[a]pplicant may be entitled to a patent because no prior artisan has been able to produce the device produced by the applicant." However, the Examiner's rejection on grounds that the enablement is not commensurate with the scope of the claims is based on the incorrect legal premise that a generic claim cannot literally cover species that are not disclosed and may be beyond the ability of a person of ordinary skill in the art given appellants' specification at the time of filing of the patent application. Because that rejection is contrary to law, it should be reversed.

In predictable arts such as those involved in this case, a broad claim can be enabled by the disclosure of a single embodiment and should not be rejected for lack of enablement merely because it could read on another embodiment that is inadequately disclosed or not even existing at the time of the application. An applicant need not discover or identify every possible way of making a claimed invention before filing for patent protection. As explained in *In re Hogan*, 559 F.2d 595, 194 USPQ 527 (CCPA 1977), enablement is judged as of the filing of the application at issue and post-filing events or discoveries are irrelevant to the inquiry. Here, the Examiner is not even relying on actual post-filing art but is improperly rejecting the claims based on the mere speculation that additional or future ways of achieving the claimed invention will be discovered that are not disclosed in the specification.

The scope of enablement need only bear a "reasonable correlation" to the scope of the claims as of the filing date. It is improper to limit structural apparatus claims to any particular

method of making the apparatus. It is equally improper to require that the claims be limited to the specific embodiments disclosed in the applicant's specification. The appellants' disclosure is commensurate with the scope of the claims because the novel disclosure identifies pertinent problems that must be solved to obtain the claimed density, general methods of solution to these problems, and multiple disclosed embodiments that exemplify specific solutions. In view of the predictability of the art, it is reasonable for appellants to be rewarded with the full scope of the pending claims for the limited patent term in exchange for early public disclosure of the novel teachings disclosing how appellants were the first to produce the claimed invention. Surely they should not be penalized for not having first identified or imagined all the possible ways to make the claimed apparatus.

Although the Examiner objects to the maximum device density limitation, the limitation validly serves to distinguish the prior art and characterizes the invention in terms of the objective being sought. Based on the disclosed techniques and structures, one skilled in the art will be able to determine how to use the appellants' teachings to achieve the claimed invention. Moreover, the appellants' claims cannot cover "all further improvements in density" due to the limits on the appellants' patent term being 20 years from the filing date, plus any term extensions. Finally, the Examiner's view that appellants' claims should be confined to the disclosed embodiments has no basis in fact or law where there is no language in the specification indicating any such intention or requirement. Rather than being restricted to a form of method or product-by process claims, the appellants' claims are directed to an apparatus that was admittedly enabled as of the filing date of the application.

As to the rejection under 35 U.S.C. § 103(a), the Examiner erred in relying on the appellants' background discussion of the prior art and general industry trends toward increasing memory density in combination with the observation in Denboer that five conductive layers can be used in integrated circuit chips. Even if the latter were the only technique pertinent to the claimed invention, the Denboer article is not enabling of that feature for which it has been cited, and cannot place the public in possession of either that feature or how to use it in the memory device of the appellants' claims. Indeed, the Examiner's cited information reveals a longfelt need and a prior lack of success in the industry, despite a clear motivation to produce the claimed invention, which is strong objective evidence of nonobviousness, not obviousness.

At most, the Examiner's alleged evidence illustrates only an impermissible "obvious to try" approach to obviousness in the absence of any showing as to how the appellants' discussion of the prior art and/or Denboer would have suggested to one of ordinary skill how to accomplish the claimed invention. The Examiner further erred by utilizing a "hindsight-based" obviousness analysis in the absence of any specific contents in the cited materials that would even allow one to pick and choose among the references. As stated in the Office Action of September 23, 1997, "applicant has overcome the 35 U.S.C. 103(a) rejection by persuasively arguing that while the concept of memory devices having increased density is known in the art, only applicant has been able to produce . . . the claimed device." The reinstatement of that rejection without any explanation was clearly legal error, and should be reversed.

C. Appellants' Authority and Analysis.

1. The inventions of claims 6-10, 18-19, 22-23 and 25-26 are sufficiently described in the specification such that a person of ordinary skill in the art is enabled to make and use the inventions within the meaning of 35 U.S.C. § 112 paragraph 1.

At the outset, it should be recognized that the Examiner agrees that the present application is "enabling for structures formed through the use of applicant's disclosed improved techniques and resultant structures." (Paper 16, at 2.) The Examiner also acknowledges that the "[a]pplicant may be entitled to a patent because no prior artisan has been able to produce the device produced by the applicant." *Id.* at 5. Nevertheless, the Examiner maintains a non-enablement rejection under 35 U.S.C. § 112, paragraph 1, on grounds that the specification does not enable a person skilled in the art to make the invention commensurate in scope with the claims, presumably because the claims will cover embodiments of the claimed invention that have not been invented yet and that cannot be made using the appellants' specification by one of ordinary skill as of the filing date.

The Examiner's position regarding "lack of enablement" incorrectly presumes that a proper generic claim cannot cover species that are beyond the ability of a person of ordinary skill in the art to construct from the appellants' specification at the time of filing of their application. Appellants respectfully disagree. See *Hormone Research Foundation, Inc. v. Genentech, Inc.*, 904 F.2d 1558, 1568, 15 USPQ2d 1039, 1047 (Fed. Cir. 1990) ("Merely because purer and more potent forms of the [claimed] compound might be produced using later-developed technology

does not necessarily mean that the . . . patent specification did not provide sufficient enabling disclosures as of the filing date of the application.""). Even in unpredictable arts, an applicant is not required to disclose every species encompassed by their claims. See *In re Angstadt*, 537 F.3d 498, 502-03, 190 USPQ 214, 218 (CCPA 1976).

Particularly in the predictable mechanical or electrical arts of the type involved here, a generic claim can literally cover unknown future developments and improvements even though such species are not disclosed in the specification and may be beyond the ability of a person of ordinary skill in the art at the time of the application -- even when using the teachings of the appellants' specification. See *Spectra-Physics, Inc. v. Coherent, Inc.*, 827 F.2d 1524, 1533 n.5, 3 USPQ2d 1737, 1743 n.5 (Fed. Cir.) ("If an invention pertains to an art where the results are predictable, e.g., mechanical as opposed to chemical arts, a broad claim can be enabled by disclosure of a single embodiment. . . . and it is not invalid for lack of enablement simply because it reads on another embodiment of the invention which is inadequately disclosed."), *cert. denied*, 484 U.S. 954 (1987). In short, the law does not require an applicant to discover or identify every possible way of achieving the claimed invention.

In the leading case of *In re Hogan*, 559 F.2d 595, 194 USPQ 527 (CCPA 1977), an "overbreadth" rejection was based on the scope of enablement allegedly not being commensurate with the scope of the claims. Specifically, the application had been pending since 1953 so that a question arose over whether a claim could issue in 1977 of a breadth sufficient to encompass later existing polymers developed around 1962 that were not enabled by the 1953 application. The Examiner had rejected the claims under § 112, paragraph 1, stating that "while the claims are generic in nature, applicants have, at best, only described a very limited species within the

generic class.” 559 F.2d at 605, 194 USPQ at 536. The Examiner in *Hogan* concluded that the disclosure was non-enabling as to other nondisclosed species of the claimed polymer, such as those shown in the later references, which could not be made using what was supported in the 1953 application. *Id.*

Even though the later-developed polymers did not exist in 1953 at the time of the application, the Examiner in *Hogan* (later affirmed by the Board) used that later state of the art to reject the claims for lacking enablement commensurate with the scope of the claims. 559 F.2d at 601, 194 USPQ at 533. The Court of Customs and Patent Appeals (“CCPA”) reversed in a detailed opinion that remains highly instructive here.

This Court has approved use of later publications as evidence of the state of the art *existing on the filing date* of an application. That approval does not extend, however, to the use of a later . . . publication disclosing a later (1962) existing state of the art in testing an earlier (1953) application for compliance with § 112, first paragraph. The difference may be described as that between the permissible application of later knowledge about art-related facts existing on the filing date and the impermissible application of later knowledge about later art-related facts . . . which did not exist on the filing date. Thus, if the applicants’ 1953 application provided sufficient enablement, considering all available evidence (whenever that evidence became available) of the 1953 state of the art, i.e., of the condition of knowledge about all art-related facts existing in 1953, then the fact of that enablement was established for all time and a later change in the state of the art cannot change it.

559 F.2d at 605, 194 USPQ at 537 (emphasis in original, footnote omitted). No matter what the particular field of the invention, *Hogan* establishes that later existing art cannot be used when determining enablement under section 112 as of the date of the application in question. *Id.* at 606, 194 USPQ at 538. Thus, even though the later discovered polymers cited by the PTO in *Hogan* were beyond the ability of anyone skilled in the art in 1953, the application was enabled once and for all as of 1953 by what was disclosed.

In *Hogan*, the PTO did not challenge applicants' assertion that their 1953 application enabled those of skill in the art in 1953 to make and use the claimed invention. 559 F.2d at 606, 194 USPQ at 537. As noted, the same is true here. The Examiner agrees that the application is "enabling for structures formed through the use of applicant's disclosed improved techniques and resultant structures" and that "no prior artisan has been able to produce the device produced by the applicant." (Paper 16, at 2, 5). In *Hogan*, the applicants disclosed the only then existing way to make the claimed invention, and the CCPA explained that to require the applicant to disclose in 1953 a later-developed form of the invention that did not exist until 1962 "would impose an impossible burden on inventors and thus on the patent system." 559 F.2d at 606, 194 USPQ at 537. Yet, the Examiner's rejection in this case imposes that very same "impossible burden" that was decried in *Hogan*.

When *Hogan* is properly followed, the Examiner's acknowledgements that the appellants' improved techniques and structures do enable others to practice the claimed invention and that the appellants are the first to produce the claimed invention means that enablement has been "established for all time" regardless of whatever future changes in the art may later occur. Indeed, unlike in *Hogan*, the Examiner in this case does not even have any actual later-developed art on which to rely. Instead, the Examiner has premised this non-enablement rejection on nothing more than a prediction that additional ways of achieving the appellants' invention will be discovered in the future and that those new ways will be beyond the ability of today's person of ordinary skill in the art to achieve. Such conjecture about post-filing events is irrelevant for purposes of § 112, first paragraph. If it is improper to enter a non-enablement rejection based on

later developed art that actually exists, it must be improper to do so based only on an assumption that other species and future patentable improvements will eventually be discovered.

The Examiner tries to explain that his position does not mean "that the claims must be limited to a specific example, but rather that the claims must be limited to what the applicant has enabled." (Paper 20, at 3). However, that distinction is without a difference; i.e., merely two ways of saying the same thing. Neither is a proper statement of the law. In *Hogan*, the court noted that to restrict appellants to the form of the invention disclosed "would be a poor way to stimulate invention, and particularly to encourage its early disclosure." 559 F.2d at 606, 194 USPQ at 537. Similarly, this rejection only serves to penalize the appellants for making an early disclosure of how they were the first to achieve the claimed invention, and thus should be reversed. Because the present application discloses the techniques and structures that allowed the appellants to be the first to produce the claimed invention in a manner that enables others of ordinary skill to do so as well, the application satisfies § 112, first paragraph, as of its filing date.

The relevant inquiry is whether the scope of the appellants' claims bears a "reasonable correlation" to the scope of enablement provided by the disclosure in the patent application, not whether the application enables an ordinary artisan to use nonexisting species and nonobvious improvements falling within the generic claim. The parameters for determining whether there is such a "reasonable correlation" were provided by the CCPA in the case of *In re Fisher*, 427 F.2d 833, 839, 166 USPQ 18, 24 (CCPA 1970), as follows:

It is apparent that such an inventor should be allowed to dominate the future patentable inventions of others where those inventions were based in some way on his teachings. Such improvements, while unobvious from his teachings, are still within his contribution, since the improvement was made possible by his work. It is equally apparent, however, that he must not be permitted to achieve this dominance by claims which are insufficiently supported and hence not in

compliance with the first paragraph of 35 U.S.C. 112. That paragraph requires that the scope of the claims must bear a reasonable correlation to the scope of enablement provided by the specification to persons of ordinary skill in the art. In cases involving predictable factors, such as mechanical or electrical elements, a single embodiment provides broad enablement in the sense that, once imagined, other embodiments can be made without difficulty and their performance characteristics predicted by resort to known scientific laws. In cases involving unpredictable factors, such as most chemical reactions and physiological activity, the scope of enablement obviously varies inversely with the degree of unpredictability of the factors involved.

Fisher was subsequently adhered to in *Hogan*, 559 F.2d at 606, 194 USPQ at 537-38, and more recently by the Federal Circuit in multiple cases, including *United States Steel Corp. v. Phillips Petroleum Co.*, 865 F.2d 1247, 9 USPQ2d 1461 (Fed. Cir. 1989) (discussed *infra*).

The fact that a “genus” in an unpredictable art may be enabled by “showing a representative number of species within the genus” directly contradicts the Examiner’s position that the level of ordinary skill in the art must “satisfy that portion of applicant’s claim scope which is beyond that enabled by the applicant.” See *Angstadt*, 537 F.2d at 502-03, 190 USPQ at 218.¹ 35 U.S.C. 112, first paragraph, only requires a “reasonable correlation,” and not a one-to-one identity, between the claim scope and the enablement provided to a person of ordinary skill in the art at the time the application was filed. See *SRI Int’l v. Matsushita Elec. Corp. of*

¹ See also *In re Goffe*, 542 F.2d 564, 567, 191 USPQ 429, 431 (CCPA 1976) (claims cannot be limited so that a competitor would merely have to follow the patent disclosure to find a substitute; this would not serve the constitutional purpose of promoting progress in the useful arts); *In re Newton*, 163 USPQ 34, 39 (CCPA 1969) (in a mechanical case, “the claims are supported by the disclosure in the sense that the broad claims read on the specific embodiment described”); *Gould v. Mossinghoff*, 229 USPQ 1, 14 (D.D.C. 1985) (“A broad mechanical claim . . . can be supported by disclosure of a single embodiment of the claimed invention. Such claims can be sustained even if they cover other inoperative or inadequately disclosed forms of the invention.”), *aff’d in part, vacated in part*, *Gould v. Quigg*, 822 F.2d 1074, 3 USPQ2d 1302 (Fed. Cir. 1987); *Beale v. Schuman*, 212 USPQ 291, 294 (Bd. Pat. Interf. 1980) (an inventor need not limit his claims to precisely what he has found will work in order to ease the path of a would be infringer) (discussed *infra*).

America, 775 F.2d 1107, 1121, 227 USPQ 577, 585 (Fed. Cir. 1985) (noting that structural claims are not to be limited to devices that operate precisely as a specification-described embodiment is operated). Without question, claims can validly encompass undisclosed forms or species of a claimed invention.

In contrast to the level of ordinary skill in the art, the breadth of the disclosure and the predictability of the art are more important factors in determining how far an applicant's claim scope may reasonably extend given an applicant's disclosure at the time of filing of the patent application. See *Hogan*, 559 F.2d at 606, 194 USPQ at 537 (fundamental inquiry is to determine the scope of protection that the applicant's particular contribution to the art is entitled). Even in an unpredictable art, species beyond the ability of one of ordinary skill to discern from the application's disclosure will remain to be identified or discovered, but will still fall within the proper scope of a generic claim.

In the present case, the appellants' disclosure bears a "reasonable correlation" to the scope of the claims because the appellants' novel disclosure includes identification of pertinent problems that must be solved to obtain the claimed density, identification of methods of solution to these problems, and multiple disclosed embodiments which are merely examples of specific solutions. There is a teaching of general methods of design of high-density dynamic random access memory, quite apart from the specific integrated circuit structures described in the specification. This broad disclosure, in view of the predictability of the art, provides a basis upon which others may conceive of additional embodiments, including embodiments that are beyond the ability of a person of ordinary skill in the art given appellants' disclosure at the time of filing the patent application. See *United States v. Telectronics, Inc.*, 857 F.2d 778, 786, 8

USPQ2d 1217, 1223 (Fed. Cir. 1988) (claims are enabled where one embodiment is admittedly disclosed in the specification along with the general manner in which the parameters for achieving the claimed invention can be ascertained), *cert. denied*, 490 U.S. 1046 (1989).

The specification as a whole teaches the concept that the claimed density can and should be achieved by various means that do not necessarily require a decrease in the minimum capable photolithographic feature dimension "F" (referred to expressly in the specification on page 25 line 12 et seq.). For example, the memory cell structure cannot simply be shrunk to a smaller size, because this would reduce the charge stored in the memory cell capacitor below the level required for reliable operation. In other words, "the reduction in memory cell size required for high density DRAMs results in a corresponding decrease in the area available for the storage node of the memory cell capacitor. Yet, design and operational parameters determine the minimum charge required for reliable operation." (Specification, page 8, lines 3 to 11.)

The general methods of solution include various techniques that improve memory cell structure to more effectively use the available area. These aspects include reducing bird's beak encroachment (specification, p. 7, line 1, to page 8, line 2), maximizing memory cell charge storage capacity for a given cell area (specification, p. 8, lines 3 to 11), reducing mask misalignment spacing between adjacent devices for enabling closer mask opening tolerances (specification, p. 8, lines 12-22), and using a comparatively larger number of conductive line layers in order to take full advantage of the elimination of field oxide regions between certain adjacent memory cells (specification, p. 8, line 23, to page 9, line 2).

Specific techniques for reduction of bird's beak encroachment include the use of a dry, high pressure, O₂ oxidizing ambient for oxidizing conditions (specification, p. 7, lines 20-22; p.

12, line 7 to p. 13, line 14), forming field oxide regions in a manner which favorably minimizes bird's beak size (specification, p. 7, lines 22-24; p. 13 line 15 to p. 15 line 2), and elimination of field oxide regions between certain adjacent memory cells (specification, p. 7, line 24 to p. 8, line 2).

Specific techniques for maximizing capacitance within a given area include trench and container-shaped stacked capacitors (specification, p. 8, lines 10-11), and an alternative technique of roughening polysilicon surfaces of the memory cell capacitor plates (specification, p.8, lines 12-13; p.15 line 3 to p. 20 line 2).

Specific techniques for reducing mask misalignment spacing between adjacent devices for enabling closer mask opening tolerances include trade-offs between misalignment tolerances in various directions; for example, a misalignment tolerance is permitted in a vertical direction as opposed to a horizontal direction (specification, p. 20, line 3, to p. 23, line 5).

The above techniques can be used separately and together as shown in FIGs. 24 and 25, and as described in the specification on page 23 line 6 to page 26 line 6.

A memory cell structure with reduced field oxide regions between certain adjacent memory cell areas is shown in FIG. 26 and described in the specification on page 26, line 7, to page 27, line 22.

Bit line circuitry requirements and associated bit line spacing also should be taken into consideration to achieve shrinking of the individual memory cells. In particular, a vertical three level twist or swap design of D and D* facilitates achieving preferred equal bit line lengths running on the upper and lower levels of the design. Three variations are described with reference to FIGS. 27, 28, 29, and 30 (specification, page 27, line 23, to page 30, line 4).

The above teachings from the appellants' specification show that there is a broad disclosure of both general teachings and numerous specific examples, sufficient to support generic claims which cover embodiments that are presently unknown and hence inadequately disclosed at the time of filing of the application. While such claims would be permissible even in an unpredictable art, the appellants' disclosure is directed to electrical circuits formed by integrated circuit structures. The properties of such circuits, and the fabrication of such circuits by the techniques described in the patent application, are predictable. See, e.g., *In re Vaeck*, 947 F.2d 488, 495, 20 USPQ2d 1438, 1445 (Fed. Cir. 1991) (a mechanical or electrical element is a predictable factor). Therefore, appellants cannot be restricted to claims no broader than the disclosed embodiments, or that which is within the ability of a person of ordinary skill in the art viewing appellants' specification at the time of filing. See *Teletronics*, 857 F.2d at 786, 8 USPQ2d at 1223 (rejecting argument that claims not limited to the specific embodiment shown in the specification were not enabled).

The Examiner has also asserted that "applicant's claims are written in terms of maximum device density" and "[a]s such, the scope of the applicant's claims includes all devices having the density achieved by applicant as well as all future improvements in density, made through any means, known or unknown." (Paper 16, at 3). However, the Examiner's position is based on an incorrect statement of fact. The appellants' claims cannot cover "all future improvements in density" since the applicable patent term cannot extend more than 20 years from the application filing date, plus any term extensions to which appellants may be entitled. See 35 U.S.C. 154. In any event, such claims are not improper. See *Scripps Clinic & Research Foundation v. Genentech, Inc.*, 927 F.2d 1565, 1572, 18 USPQ2d 1001, 1006 (Fed. Cir. 1991) ("Open-ended

claims are not inherently improper' as for all claims their appropriateness depends upon the particular facts of the invention, the disclosure, and the prior art. . . . They may be supported if there is an inherent, albeit not precisely known, upper limit and the specification enables one of skill in the art to approach that limit.'").

In this case, the memory cell density limitation in the claims at issue on appeal necessarily serves to distinguish prior art devices of lower densities in a clear and concise way. The memory cell density limitation also characterizes the invention in terms of the objective being sought. Moreover, the memory cell density is the primary characteristic of commercial significance. Armed with the teachings in the disclosure in the application, one of skill in the art will be able to determine without undue experimentation how best to employ the various techniques and structures. As discussed above, the memory cell structure cannot simply be shrunk to a smaller size because there is an inherent limit to the level of stored charge required for reliable operation.

Although not discussed in the Examiner's final rejection, the prosecution history repeatedly cites *In re Mayhew*, 527 F.2d 1229, 188 USPQ 356 (CCPA 1976), as support for the rejection under 35 U.S.C. 112, first paragraph. In *Mayhew*, the specification showed that certain features of a cooling apparatus were *essential* to the claimed method. *Id.* at 1233, 188 USPQ at 358. For example, the specification stated that raising the strip and bath over optimum coating temperatures "*is practical because of special cooling apparatus, specially located.*" *Id.* (emphasis by CCPA). That specification also stated that "[i]f high temperature galvanizing spelter were present . . . , iron dissolution and dross formation would make it *impossible to produce the smooth coat produced by the present invention.*" *Id.* at 1234, 188 USPQ at 361

(emphasis added). Thus, the facts of *Mayhew* unambiguously revealed that the cooling apparatus and its location were essential to the claimed invention (i.e., was impossible without) so that the Court held that method claims failing to recite such essential steps were not enabled by the specification. *See* 527 F.2d at 1233, 188 USPQ at 358.

In contrast to *Mayhew*, appellants' specification has no language indicating that the claims necessarily are or were intended to be confined to the disclosed embodiments. To the contrary, appellants' disclosure expressly states that "[o]ne or more of the [disclosed] techniques, *or other techniques*, can be utilized in the production of 64M, 16M or 4M memory chips in accordance with the invention, with the invention only being limited by the accompanying claims appropriately interpreted in accordance with the doctrine of equivalents." (specification, p. 9, lines 3-7 (emphasis added).) The appellant's disclosure further states that the specifically disclosed methods of achieving high device density are provided by way of example only and not by way of limitation. (*See, e.g.*, p. 37, lines. 21-24. and p. 39, lines. 5-8.) Thus, the *Mayhew* decision cannot be deemed applicable to the present case for at least the reason that its facts are not analogous.²

² The concurring opinion in *Mayhew* shows that the majority's ruling was likely based on the fact that certain claims did not recite what that applicant, in his own words, regarded as his invention for purposes of 35 U.S.C. 112, second paragraph. 527 F.2d at 1235, 188 USPQ at 360. See *Gentry Gallery Inc. v. Berkline Corp.*, 134 F.3d 1473, 1479, 45 USPQ2d 1498, 1503 (Fed. Cir. 1998)(the disclosure makes clear that the inventor considered the location of the recliner controls on the console to be an essential element of the invention); cf. *Johnson Worldwide Associates Inc. v. Zebco Corp.*, 175 F.3d 985, 993, 50 USPQ2d 1607, 1613(Fed. Cir. 1999) ("*Gentry Gallery*, then, considers the situation where the patent's disclosure makes it crystal clear that a particular (i.e. narrow) understanding of a claim term is an essential element of [the inventor's] invention."). Even then, that is not the situation here.

The present facts are more analogous to those in *Beale v. Schuman*, 212 USPQ 291 (Bd. Pat. Interf. 1980), where the Board correctly realized that *Mayhew* did not apply where nothing in an applicant's specification required the claims to be limited to the disclosed embodiments. *Id.* at 293. The application at issue in *Beale* was to a free-piston engine with means to permit a working gas to leak by the piston. The specification only disclosed embodiments with gas passages on the cylinder walls. *Id.* at 291, 293. Yet, the Board held the specification adequate to enable a claim that encompassed structures with gas passages formed on either a cylinder, or on both a piston and a cylinder.

We find nothing in the Schuman disclosure which requires the gas passages to be confined solely to the cylinder walls as argued by Beale. . . . An inventor is not required to limit his claims to a specific example or examples disclosed in his application.

212 USPQ at 293. As shown by *Beale*, the rationale of *Mayhew* should only be invoked to narrow claims when a disclosure indicates that particular steps are required for what an applicant regards as the invention. A mere description of specific enabled embodiments or examples is not enough. Rather, there must be express language in the disclosure like that in *Mayhew* (i.e., that achieving the claimed invention would be essentially "impossible" without the embodiments shown) before such a requirement can be imposed. In contrast to *Mayhew*, the appellants' disclosure, like that in *Beale*, has no language that would confine appellants' claims to the disclosed embodiments. Indeed, it does just the opposite.

Further, the claims at issue in *Mayhew* were to a method while the claims at issue in *Beale* were to an apparatus. On that additional basis, the apparatus claims at issue here are more analogous to *Beale* than *Mayhew*. With respect to *apparatus* claims, the Board in *Beale* held that "broad claims may be supported by a specific embodiment . . . and an inventor need not limit his

claims to precisely what he has found will work.” 212 USPQ at 294. Likewise, the appellants’ apparatus claims should not be limited to the actual disclosed methods by which the claimed device has been produced. Such an analysis would in effect transform the claims into “product-by-process” claims, which is not what the appellants “regard” as their invention in the appealed claims. Appellants’ claims should not be reduced to *de facto* product-by-process claims, even under *Mayhew*, because the specification reveals no need, requirement, or intention for any method limitations in the apparatus claims.

Nevertheless, the Examiner has asserted that the specification “does not reasonably provide enablement for memory structures having the claimed density not made through at least one of applicant’s improved techniques.” (Paper 16, at 3) The Examiner also faults applicants for not “enabling one skilled in the art to make the claimed invention through use of an undisclosed method.” *Id.* at 4. However, applicants are claiming a new device not previously produced, not a particular method for making it. There is no requirement under the law that applicants must discover all possible methods of making a new apparatus in order to enable a claim to that new apparatus. Instead, § 112 only requires that an application enable one of ordinary skill in the art at the time of the application to make the claimed invention from what is disclosed in the specification. Thus, as the above discussion establishes, appellants’ claims are in full compliance with 35 U.S.C. §112, first paragraph, under the authority of *Beale* and the Federal Circuit precedent cited above.

Finally, returning to *Hogan*, the PTO’s final argument was that the claim at issue was broad enough to cover the later-developed state of the art and thus might be enforced against the later developers. Once again, the CCPA dismissed that concern.

Any such conjecture, if it exists, is both irrelevant and unwarranted. The business of the PTO is patentability, not infringement. Like the judicially-developed doctrine of equivalents, designed to protect the patentee with respect to later-developed variations of the claimed invention, the judicially-developed "reverse doctrine of equivalents," requiring interpretation of claims in light of the specification, may be safely relied upon to preclude *improper* enforcement against later developers. The courts have consistently considered subsequently existing states of the art as raising questions of infringement, but never of validity. It is, of course, a major and indefinitely important function of the PTO to insure that those skilled in the art are enabled, as of the filing date, to practice the invention claimed. If, in light of all proper evidence, the invention claimed be clearly enabled as of *that* date, the inquiry under § 112, first paragraph, is at an end.

559 F.2d at 607, 194 USPQ at 538 (emphasis in original, footnotes omitted). Because the Examiner has agreed that the specification enables one skilled in the art to practice the claimed invention as disclosed by the first persons to produce the claimed device, the present inquiry under § 112, first paragraph, should have been at an end.

Subsequently in *United States Steel Corp. v. Phillips Petroleum Co.*, 865 F.2d 1247, 1251, 9 USPQ2d 1461, 1464-65 (Fed. Cir. 1989), the Federal Circuit explained that "the word 'overbreadth' alone has long ago been discredited as a basis for determining the sufficiency of a specification." Confirming the holding in *Hogan*, the Federal Circuit rejected the argument that a patent claim that embraces subject matter for which no adequate basis exists in the disclosure is too broad, and held that an argument complaining that the claims cover a later-developed version of the claimed invention was a matter of infringement, not validity.³ *Id.* at 1250-51, 9 USPQ2d at 1465. Even though the form of the invention enabled by a later-discovered catalyst had long been recognized in the art as being desirable, that evidence did not mean the claims were not

³ The Federal Circuit in *United States Steel* subsequently affirmed the finding that the reverse doctrine of equivalents provided no basis for limiting that claim to less than its admitted literal scope. *Id.* at 1253, 9 USPQ2d at 1466.

enabled as of the filing date. *Id.* Thus, that memory devices of the claimed density have been recognized in this art as being desirable does not alter that the appellants are the first to achieve and enable the claimed invention.

Thus, for all of the reasons set forth above, the Examiner's rejections under § 112, first paragraph, of claims 6-10, 18-19, 22-23 and 25-26 are improper and should be reversed.

2. The Inventions of Claims 6-10, 18-19, 22-23 and 25-26 are Patentable under 35 U.S.C. 103(a) over Appellants' Discussion of the Prior Art in View of Denboer ("Inside Today's Leading Edge Microprocessors," Semiconductor International, 1/1994).

The Examiner has also rejected the claims under 35 U.S.C. § 103(a) as being unpatentable over the appellant's discussion of the prior art in the specification in view of the Denboer article. As described above, the appellants' claims recite a 16M semiconductor memory device having at least a certain density of memory cells. Claims 6 to 10 define a density of from 16,000,000 to 17,000,000 functional and operably addressable memory cells arranged on a die having a total combined area which is no greater than 14 mm². Claims 18 to 19, 22 to 23, and 25 to 26 define an area of 100 square microns of continuous die surface area having at least 128 functional and operably addressable memory cells.

According to the Examiner, the appellants' own specification discusses 16M chips as well as the industry desire to increase memory density while Denboer reviews various new chips (as of 1993) and observes that the smallest of such chips uses five conductive layers. Without more, the Examiner concludes that one skilled in the art producing 16M chips with the desire to make them smaller would be led to use five conductive layers. Even if that were the only

technique needed to achieve the claimed invention, there is no instruction in Denboer nor the appellants' discussion of the prior art and the industry's desires for greater density that would make it obvious to make the claimed invention.

To support a § 103 rejection, a prior art printed publication must be enabling of the features for which it has been cited, thus placing the allegedly disclosed subject matter in the possession of the public. *In re Epstein*, 32 F.3d 1559, 1567-68, 31 USPQ2d 1817, 1823 (Fed. Cir. 1994). Neither the appellants' discussion of the prior art nor the Denboer article provide an enabling disclosure of a semiconductor memory device having the claimed density of memory cells. Denboer is nothing more than a survey report on microprocessor designs introduced in 1993. The Examiner's position appears to be that one skilled in the art of producing 16M chips with the desire to make them smaller would be led to the use of five conductive layers given Denboer's mention of that technique being used in the IBM PC601 chip. Even if it assumed that is what IBM in fact did, there is nothing in Denboer that provides an enabling disclosure of that feature, much less of how to use it in a semiconductor memory device having the density of the appellants' claims.

Viewed in that light, Denboer actually provides strong objective evidence that the appellants' claimed invention would not have been obvious. The second page of the Denboer article recites that the IBM PC601 chip "has the smallest die size, but uses the most complex technology: 5 levels of metal, chemical-mechanical planarization, and incredibly accurate overlay registration." Therefore, even though Denboer, and presumably the IBM chip designers, realized that it was highly desirable to have the smallest possible die size, there is no disclosure in Denboer indicating that the appellants' claimed density had been achieved or would even have

been possible at that time despite the best efforts of the IBM chip designers (who likely were of greater than ordinary skill in the art at that time).

The § 103(a) rejection in this case was previously withdrawn by the Examiner in the Final Official Action mailed Sept. 23, 1997. At that time, the Examiner stated that "applicant has overcome the 35 U.S.C. 103(a) rejection by persuasively arguing that while the concept of memory devices having increased density is known in the art, only applicant has been able to produce . . . the claimed device." *Id.* at 3, paragraph 3. Subsequently, the Examiner reinstated the § 103 rejection without any explanation. Even so, the Examiner still continued to concede -- in the context of the non-enablement rejection -- that "it would appear that the semiconductor industry has been unable to produce applicant's claimed structure despite having a continuing goal to do so." (Paper 16, at 4).

In practical effect, the Examiner's own observations provide confirmation that the appellants satisfied a long-felt need in the art when they became the first to produce the claimed invention. The failure of others to solve a long-standing problem is objective evidence of non-obviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1966) ("Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy."). Of course, the Examiner cannot use appellants' specification for evidence of how to use five conductive layers to produce 16M chips of the claimed density. The appellants' own novel disclosure is not "prior art" as to the appellants.

Moreover, it is legal error to combine features from prior art references to create the claimed invention in the absence of any suggestion or motivation in the prior art to do so. See *In re Dembiczaik*, 175 F.3d 994, 999, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999) (rejecting “hindsight-based” analysis) (citing *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 1138, 227 USPQ 543, 547 (Fed. Cir. 1985) (“The invention must be viewed not with the blueprint drawn by the inventor, but in the state of the art that existed at the time.”)). Here, all that the Examiner has pointed to is an industry desire to make higher density memory and a historical pattern that the industry has been able to accomplish that goal every few years. Such statements cannot substitute for actual proof that the claimed invention would have been obvious to one of ordinary skill in the art. See *Dembiczaik*, 175 F.3d at 999-1000, 50 USPQ2d at 1617 (actual evidence and particular findings need to support the PTO’s obviousness conclusion).

In *Hybritech, Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 231 USPQ 81 (Fed. Cir.), *cert. denied*, 480 U.S. 947 (1986), the Federal Circuit reversed an obviousness holding where the district court relied on four prior art articles that referred to the subject of the claimed invention as a future possibility without suggesting how that end could be accomplished. Any reliance on such articles to show that it would have been “obvious to try” to achieve the claimed invention was rejected as error. *Id.* at 1380, 231 USPQ at 91 (citing *Jones v. Hardy*, 727 F.2d 1524, 1530, 220 USPQ 1021, 1026 (Fed. Cir. 1984) (“Obvious to try” is improper consideration in adjudicating obviousness issue)). Here, the Examiner’s reliance on general statements regarding the industry’s motivation and prior increases in memory density is nothing more than a recognition that it would have been “obvious to try” to continue that progression.

In *Monarch Knitting Machinery Corp. v. Sulzer Morat GMBH*, 139 F.3d 877, 45 USPQ2d 1977 (Fed. Cir. 1998), the Federal Circuit vacated a summary judgment of obviousness where the district court had based its conclusion on the prior art showing a “trend” towards the claimed invention. Noting that a “trend” might be a sufficient suggestion or teaching to one of ordinary skill to make “minor” changes from the prior art to produce the claimed invention, the court further noted that “[t]he existence of a trend depends upon the content of the prior art at the time of the invention.” *Id.* at 881-82, 45 USPQ2d at 1981. Even before a trend could be found, there would need to be a suggestion or motivation even to recognize the trend. *Id.* at 882, 45 USPQ2d at 1982 (citing *Orthopedic Equip. Co. v. United States*, 702 F.2d 1005, 1012, 217 USPQ 193, 199 (Fed. Cir. 1983) (“It is wrong to use the patent in suit as a guide through the maze of prior art references, combining the right references in the right way so as to achieve [a desired result].”)). Here, the Examiner did not even cite any actual prior art references to combine, much less show a suggestion therein of how it would have been obvious to make “minor” changes to the prior art to achieve the claimed invention.

Finally, the Examiner’s reliance on the appellants’ discussion of the prior art in the specification as somehow being evidence of obviousness is without merit. A similar attempt was rejected in *In re Dow Chemical Co.*, 837 F.2d 469, 472, 5 USPQ2d 1529, 1531 (Fed. Cir. 1988), where the Board had held that Dow’s statement in its specification “that it was known that styrene/maleic anhydride copolymers had improved heat resistance as compared with styrene rubbers, made it *prima facie* obvious to combine the three components” to achieve the claimed invention.

Indeed, the record shows that such combinations had previously been made, in various ways, without producing the product here desired. That there were other

attempts, and various combinations and procedures tried in the past, does not render obvious the later successful one. The PTO's reliance on Dow's "admission" of longfelt need as *prima facie* evidence of obviousness is contrary to logic as well as law. . . . Further, a patent applicant's statement of the purpose of the work is not prior art.

Id. Here, the discussion of the prior art in the appellants' specification cited by the Examiner is even less specific than in *Dow*. Just as in that case, the fact that no one made the claimed invention before appellants, and the evidence of the industry's motivation to achieve and its longfelt need for the claimed invention supports nonobviousness, not obviousness. Thus, for the reasons set forth above, the Examiner's rejection under § 103(a) of claims 6-10, 18-19, 22-23 and 25-26 should also be reversed.

D. Conclusion.

For the above reasons, the Examiner's rejections of claims 6-10, 18-19, 22-23 and 25-26 are improper. Appellants therefore request reversal of the final rejection of claims 6-10, 18-19, 22-23 and 25-26. Allowance of such claims is also respectfully requested.

Respectfully submitted,



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IX. APPENDIX - THE CLAIMS INVOLVED IN THIS APPEAL.

6. A 16M semiconductor memory device comprising:

a semiconductor die encapsulated in a package, the package having an encapsulating body and electrically conductive interconnect pins extending outwardly from the body; a total of from 16,000,000 to 17,000,000 functional and operably addressable memory cells arranged in multiple memory arrays formed on the die, the individual functional and operably addressable memory cells occupying area on the die within the memory arrays, the occupied area of all functional and addressable memory cells on the die having a total combined area which is no greater than 14 mm²; and

peripheral circuitry and pitch circuitry formed on the die relative to the memory arrays; the peripheral circuitry electrically interconnecting with the pins and including operably interconnected control and timing circuitry, address and redundancy circuitry, data and test path circuitry, and voltage supply circuitry which collectively enable full access to all addressable memory cells of the memory arrays.

7. The semiconductor memory device of claim 6 wherein the peripheral circuitry, the pitch circuitry, and the memory arrays are fabricated to include a total of four or less conductive line layers.

8. The semiconductor memory device of claim 6 wherein the peripheral circuitry, the pitch circuitry and the memory arrays have a total combined continuous surface area on the die which is less than or equal to 35 mm².

9. The semiconductor memory device of claim 6 wherein the peripheral circuitry, the pitch circuitry, and the memory arrays are fabricated to include at least five conductive line layers, the occupied area of all functional and operable memory cells on the die having a total combined area on the die which is no greater than 11 mm².

10. The semiconductor memory device of claim 6 wherein the peripheral circuitry, the pitch circuitry, and the memory arrays are fabricated to include at least five conductive line layers; the peripheral circuitry, the pitch circuitry and the memory arrays having a total combined continuous surface area on the die which is less than or equal to 32 mm².

18. A 16M semiconductor memory device comprising:

a semiconductor die encapsulated in a package, the package having an encapsulating body and electrically conductive interconnect pins extending outwardly from the body;

a total of from 16,000,000 to 17,000,000 functional and operably addressable memory cells arranged in multiple memory arrays formed on the die, at least one of the memory arrays containing at least one area of 100 square microns of continuous die surface area having at least 128 of the functional and operably addressable memory cells; and peripheral circuitry and pitch circuitry formed on the die relative to the memory arrays; the peripheral circuitry electrically

interconnecting with the pins and including operably interconnected control and timing circuitry, address and redundancy circuitry, data and test path circuitry, and voltage supply circuitry which collectively enable full access to all addressable memory cells of the memory arrays.

19. The semiconductor memory device of claim 18 wherein at least one of the memory arrays containing at least one area of 100 square microns of continuous die surface area has at least 170 of the functional and operably addressable memory cells.

22. A semiconductor memory device comprising:
a total of no more than 68,000,000 functional and operably addressable memory cells arranged in multiple memory arrays formed on a semiconductor die, and circuitry formed on the semiconductor die permitting data to be written to and read from one or more of the memory cells, at least one of the memory arrays containing at least one area of 100 square microns of continuous die surface area having at least 128 of the functional and operably addressable memory cells.

23. The semiconductor memory device of claim 22 wherein the total number of functional and operably addressable memory cells on the semiconductor die is no more than 17,000,000.

25. The semiconductor memory device of claim 22 wherein at least one of the memory arrays containing at least one area of 100 square microns of continuous die surface area has at least 170 of the functional and operably addressable memory cells.

26. The semiconductor memory device of claim 22 wherein at least one of the memory arrays containing at least one area of 100 square microns of continuous die surface area has at least 170 of the functional and operably addressable memory cells, and the total number of functional and operably addressable memory cells on the semiconductor die is no more than 17,000,000.